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(54) **HAMMER FOR A MATERIAL SIZE REDUCTION MACHINE**

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(51) **Int. Cl.**
B02C 13/00 (2006.01)

(52) **U.S. Cl.** **241/194**; 241/195

(58) **Field of Classification Search** 241/195, 241/191, 194, 185.5, 190
See application file for complete search history.

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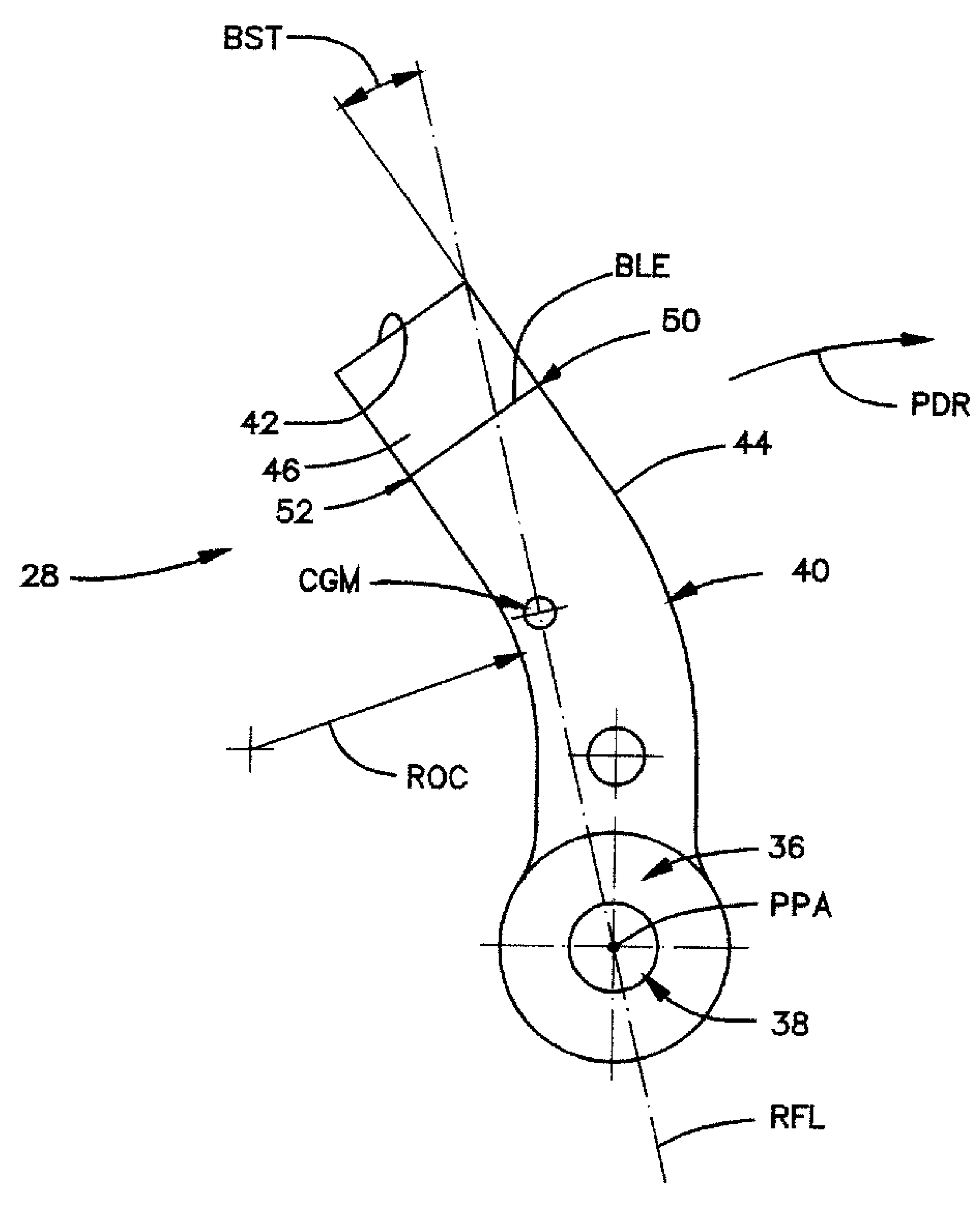
(57) **ABSTRACT**

A hammer **28** is provided for a material size-reducing machine of the type including a rotor on which the hammer is individually pivotally mounted. The hammer **28** includes a mounting end **36** having a throughbore for receiving a pivot pin therethrough in connection with the pivot mounting of the hammer on the rotor, an extending portion **40** with the center of mass CGM located therein. The extending portion has a non-linear body portion **44** and a linear body portion **46** with the linear body portion **46** being inclined in a direction opposite to the rotation direction at an angle between 5 to 45 degrees as measured relative to a line RFL extending through the center of the pivot pin and the center of mass CGM of the hammer.

6 Claims, 4 Drawing Sheets



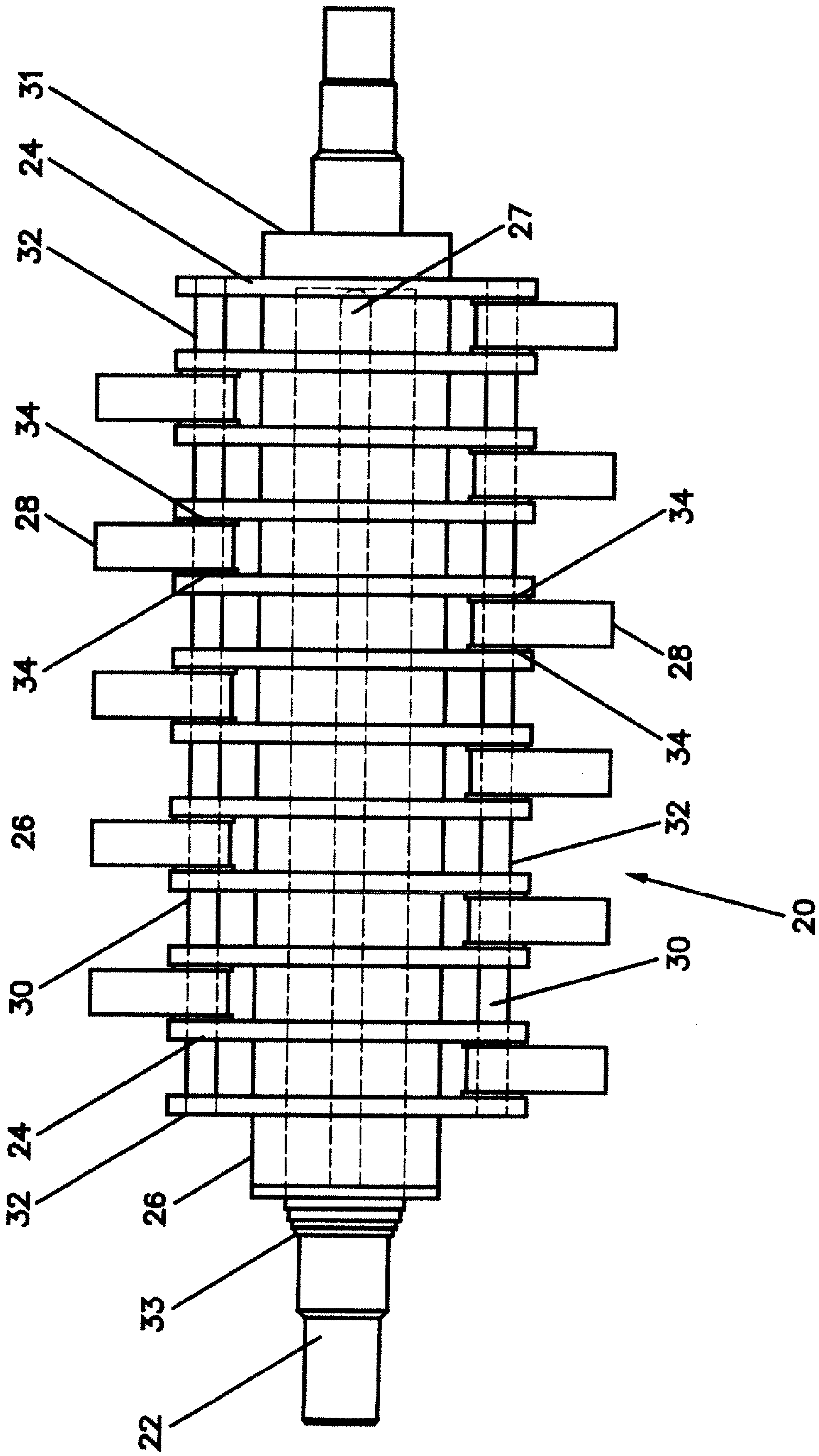


Figure 1
Prior Art

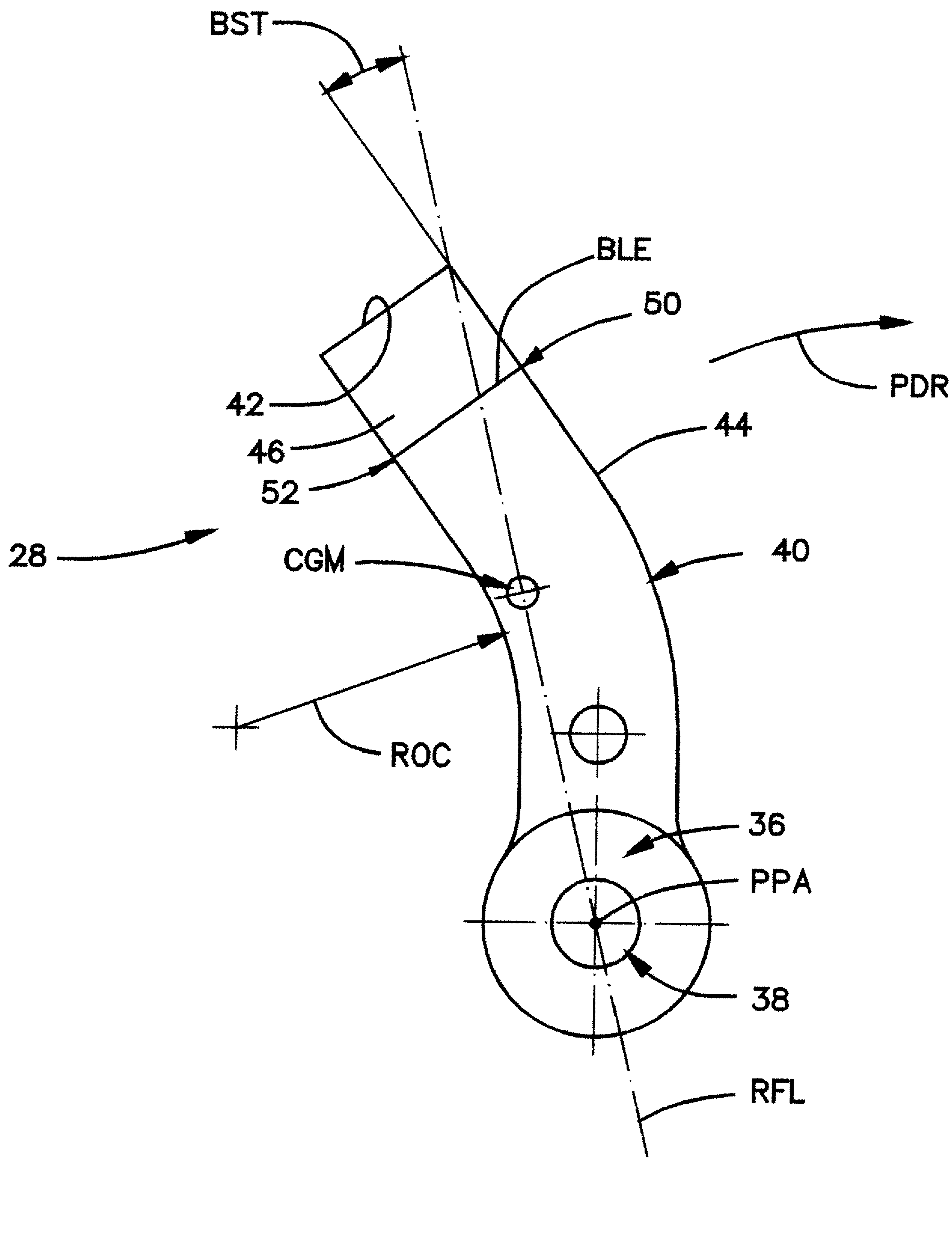
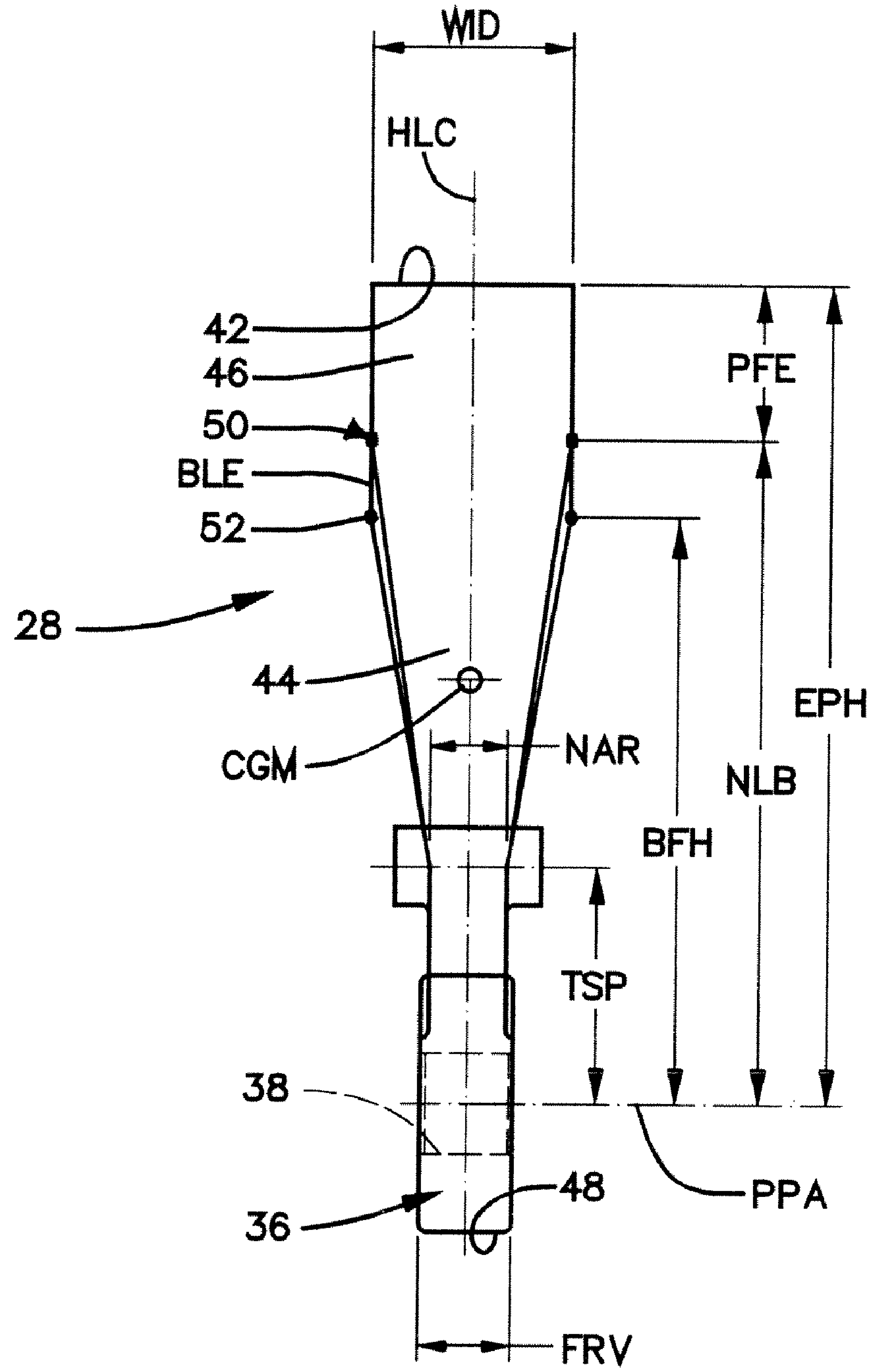


Figure 2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FRV

Figure 3

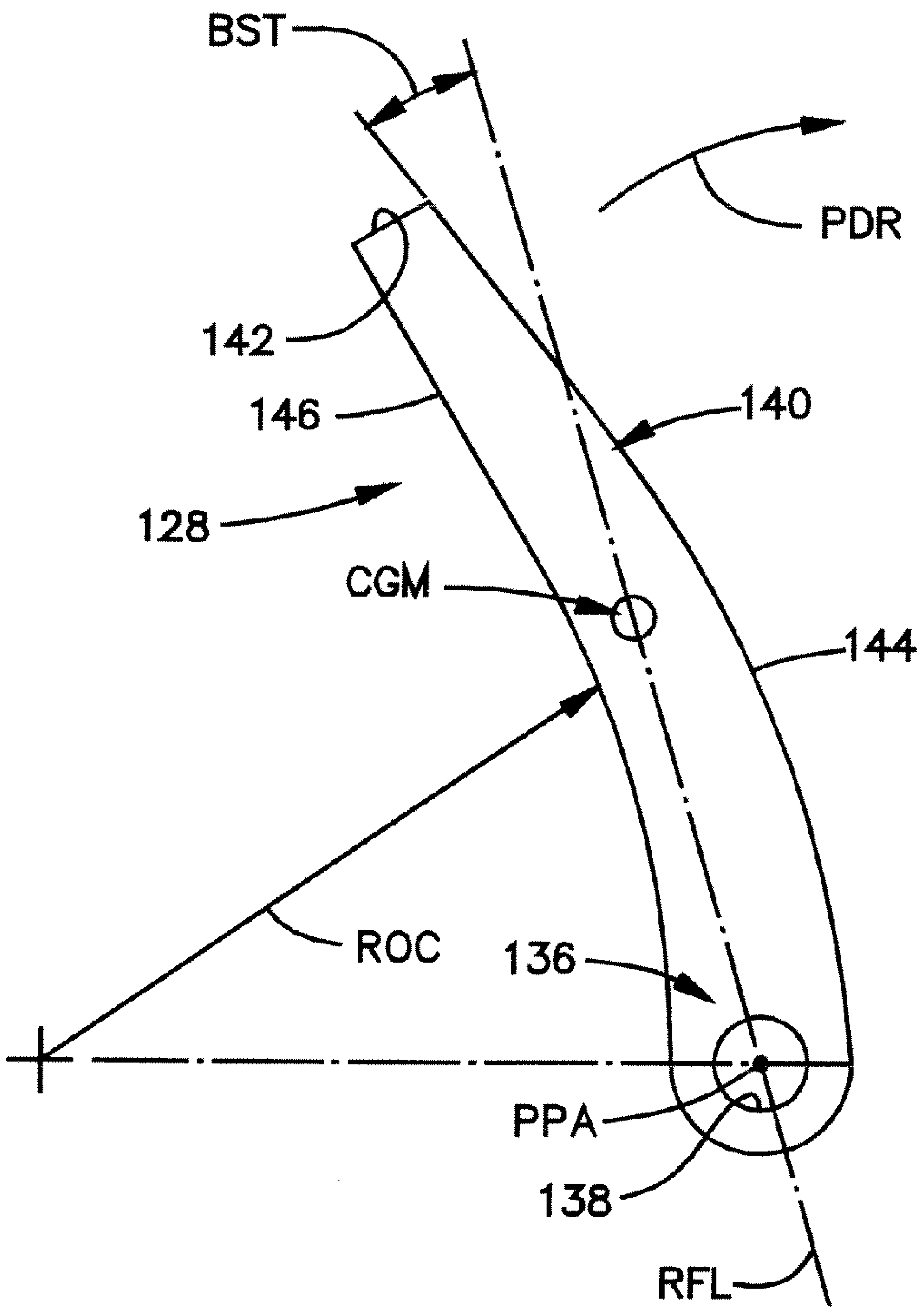

Figure 4

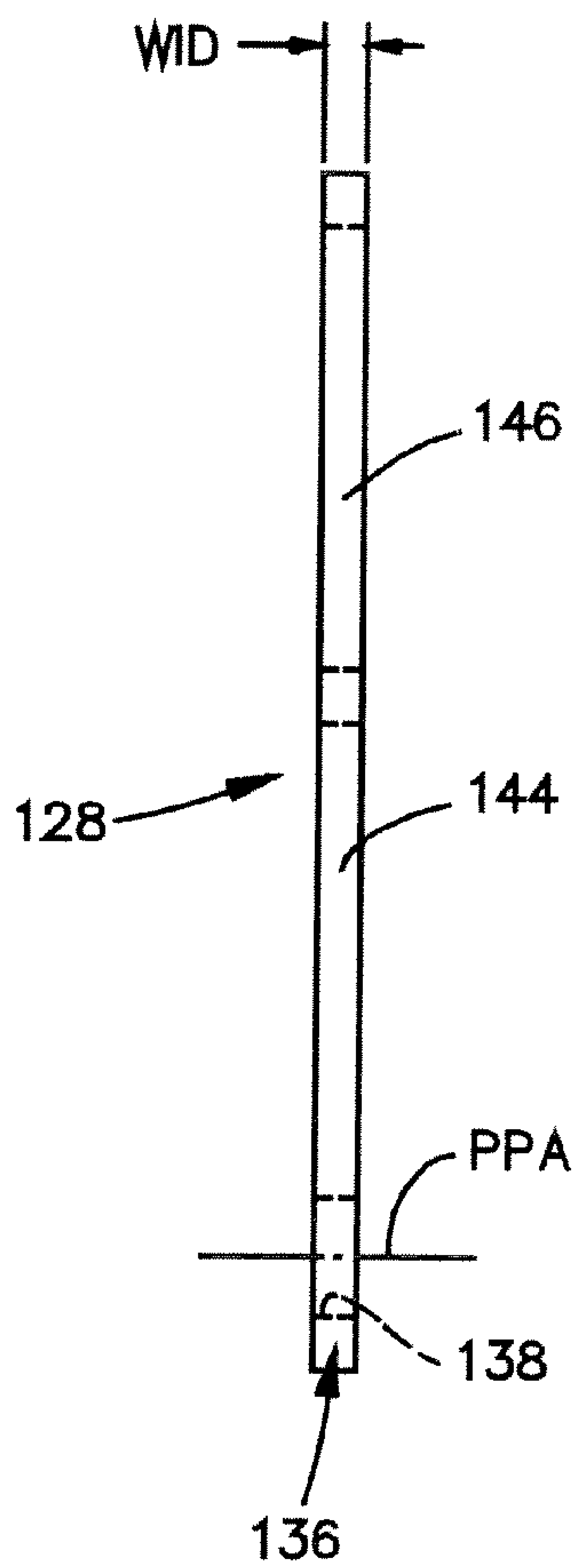

Figure 5

HAMMER FOR A MATERIAL SIZE REDUCTION MACHINE

BACKGROUND OF THE INVENTION

The invention relates to a hammer for a material size reduction machine.

Typically, in conventional hammer mills, a large number of hammers are individually pivotally mounted on a rotating drum or disk rotating at high speed. The hammers are rotated at high speed and sweep adjacent the inner circumferential wall of a mill housing, whereupon particles to be size reduced are fed into the mill and collide with the front faces of the hammers.

To achieve a desired high output, and because of the wide variety of materials that must be processed by these material size reducing machines, the hammer mills or rotors must be very heavily constructed to provide the necessary strength for effective operation and durability. Additionally, a heavy hammer mill or rotor will also have a large amount of angular momentum and energy to effectively process tough, high strength materials and also maintain a relatively constant rotational speed, resulting in less wear on the drive train and engine.

Dimensional constraints and the severity of operating conditions must be considered with respect to the construction and configuration of a hammer. The hammers are typically pivotally mounted to the periphery of a rotating drum or disk. One problem associated with such machines is the regular need to replace damaged or worn hammers, this need being engendered by the high rates of rotation and the impact energies associated with the contact of the hammers with the particulate material to be size reduced.

Attempts have been made to improve the durability of such hammers by, for example, hardening of contact surfaces of the hammer. However, the need still exists for a hammer that offers a more favorable impact wear characteristic

Accordingly, it is an object of the present invention to provide a hammer that addresses the concerns set forth above.

SUMMARY OF THE INVENTION

According to the present invention, a hammer is provided for a material size reducing machine of the type including a rotor on which the hammer is individually pivotally mounted, whereupon the inventive hammer advantageously offers a more favorable impact wear characteristic. The inventive hammer advantageously provides a higher grinding efficiency because of a) stronger secondary breakage by the shortened particle-traveling distance and higher particle velocity hitting the liner wall and b) a separate deflected particle passage that permits the hammer to transfer energy to the incoming particles more efficiently. Moreover, the inventive hammer offers the possibility of uniform wear, so as to provide a longer service life and to maintain a sustained peak performance.

According to one aspect of the present invention, the inventive hammer includes a mounting end having a throughbore for receiving a pivot pin therethrough in connection with the pivot mounting of the hammer on the rotor, whereupon the axis of the pivot pin when mounted through the throughbore extends parallel to the axis of rotation of the rotor. The hammer includes an extending portion extending from the mounting end and terminating in a distal end with the center of mass of the hammer being located in the extending portion.

According to a further detail of the one aspect of the present invention, the extending portion has a non-linear body portion and a linear body portion with the non-linear body portion being located intermediate the linear body portion and the throughbore.

According to yet another detail of the one aspect of the present invention, the linear body portion is inclined in a direction opposite to the rotation direction of the rotor at an angle between 5 to 45 degrees as measured relative to a line extending through the center of the pivot pin and the center of mass of the hammer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevational view of a portion of a conventional hammermill that is representative of the type of material size reducing machine on which the hammer of the present invention can be mounted;

FIG. **2** is an enlarged side elevational view of one embodiment of the hammer of present invention;

FIG. **3** is a front elevational view of the one embodiment of the hammer shown in FIG. **2**;

FIG. **4** is an enlarged side elevational view of another embodiment of the hammer of present invention; and

FIG. **5** is a front elevational view of the another embodiment of the hammer shown in FIG. **4**.

DETAILED DESCRIPTIONS OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, FIG. **1** illustrates a conventional hammermill suitable for use with the hammer of the present invention. This conventional hammermill is illustrated and described in U.S. Pat. No. 5,507,441, wherein, in that FIG. **1** of that patent and as illustrated in FIG. **1** herein, there is illustrated a hammermill **20** having a main shaft **22** which is rotated about a longitudinal axis by conventional driving mechanisms such as gas or electric powered motors. Mounted in longitudinally spaced relation along the shaft **22** are a plurality of plates **24**. Associated with the plates **24** are a plurality of hubs **26** for maintaining spacing of the plates **24** along the shaft **22**. The plates **24** each have keyways which mate with a longitudinally extended key **27** formed by the main shaft **22** for preventing relative rotation between the shaft **22** and the plates **24**. The plates **24** and hubs **26** are prevented from moving longitudinally along the main shaft **22** by an end plate **31** rigidly connected to one end of the main shaft **22** and a nut **33** threaded onto the other end of the main shaft **22** such that the plates **24** and associated hubs **26** are compressed between the end plate **31** and the nut **33**.

A plurality of free-swinging hammers **28** are pivotally mounted between the plates **24** along pivot axes parallel to and spaced from the main axis. The free-swinging hammers **28** are pivotally mounted on pivot pins **30** that are aligned along the pivot axes. The pivot pins **30** extend through linearly aligned holes **32** defined by the plates **24** at locations proximate the outer circumference of the plates **24**. The hammers **28** are free to pivot about their corresponding pivot pins **30** within the area of motion defined by contact of the hammers **28** with the main shaft **22**. The plates **24** are rotated by the main shaft **22** in a direction of rotation PDR (a clockwise direction out of the plane of the illustration of the hammermill **20** shown in FIG. **1**).

A more detailed description of the hammers **28** will now be had with reference to FIG. **2**, which is an enlarged side elevational view of one embodiment of the hammer of present invention, and FIG. **3**, which is a front elevational view of the one embodiment of the hammer shown in FIG. **2**. The hammer **28** includes a mounting end **36** having a throughbore **38** for receiving one of the pivot pins **30** therethrough in connection with the pivot mounting of the hammer between a respective adjacent pair of the plates **24**. The axis PPA of the pivot pin **30** when mounted through the throughbore **38** extends parallel to the axis of rotation of the plates **24**.

The hammer **28** also includes an extending portion **40** extending from the mounting end **36** and terminating in a distal end **42** with the center of mass CGM of the hammer being located in the extending portion **40**. The extending portion **40** has a non-linear body portion **44** and a linear body portion **46** with the non-linear body portion **44** being located intermediate the linear body portion **46** and the throughbore **38**. The linear body portion **46** is inclined in a direction opposite to the rotation direction PDR of the plates **24** at a backset angle BST between five to forty-five degrees (5 to 45°) as measured relative to a reference line RFL extending through the center of the pivot pin **30** and the center of mass CGM of the hammer. The backset angle BST is most preferably between fifteen to twenty-five degrees (15 to 25°) as measured relative to the reference line RFL.

With reference to FIG. **3**, it can be seen that the linear body portion **46** of the extending portion **40** of the hammer **28** has a planar face having height extent PFE, as measured radially to the pivot pin axis PPA from the distal end **42** to the topmost edge of the non-linear body portion **44**, is 10 to 50% of the height extent EPH of the extending portion **40**, as measured radially to the pivot pin axis PPA from the distal end **42** to the pivot pin axis PPA. The non-linear body portion **44** has a height extent NLB as measured radially to the pivot pin axis PPA from the bottom most edge of the linear body portion **46** of 50 to 90% of the height extent EPH of the extending portion **40** with the respective height extent NLB of the non-linear body portion **44** and the respective height extent EPH of the linear body portion **46** together comprising the height extent EPH of the extending portion **40**, as measured radially to the pivot pin axis PPA from the distal end **42** to the pivot pin axis PPA.

The hammer **28** has a width extent WID at the distal end **42** as measured parallel to the pivot pin axis PPA. The width extent of the hammer **28** tapers symmetrically inwardly from both sides of the non-linear body portion **44** toward a longitudinal centerline HLC of the hammer **28** from the width extent WID to its most narrow width extent NAR, which is located at a height TSP above the pivot pin axis PPA of between 20 to 70% of the height extent EPH of the extending portion **40**. Both the width extent WID of the hammer **28** at its distal end **42** and the most narrow width extent NAR of the hammer **28** are centered on the longitudinal centerline HLC. The balance of the hammer **28** from the bottom most edge of the non-linear body portion **44** to its most narrow width extent NAR to its inside end **48** has a maximum width extent FRV that can be equal to the most narrow width extent NAR of the non-linear body portion **44** or slightly larger but less than the width extent WID of the linear body portion **46**.

With reference again to FIG. **2**, it can be seen that the linear body portion **46** of the extending portion **40** of the hammer **28** is rectilinear with the faces thereof defining its width extent WID being at right angles to the faces thereof defining its height extent PFE, and these faces, in turn, being at right angles to the depth extent of the linear body portion **46** as measured along a bottom most side edge BLE of the linear body portion **46**. Thus, the distal end **42** formed by the top of the linear body portion **46** is planar and the bottom most side edges BLE of the linear body portion **46** are parallel to the distal end **42** Each bottom most side edge BLE of the linear body portion **46** thus extends at a downward incline as viewed from the right to the left in FIG. **2** from its front face terminus **50** at the front face of the hammer **28** (i.e., the respective face of the hammer **28** that contacts the material to be milled) to its back face terminus **52** at the back face of the hammer **28**. The front face terminus **50** of each bottom most side edge BLE of the linear body portion **46** is at a front face height defined by the height extent NLB of the non-linear body portion **44** that is greater than the back face height BFH of the back face terminus **52**. As seen in FIG. **2**, the non-linear body portion **44** of the extending portion **40** of the hammer **28** has a radius of curvature ROC of between ten to sixty degrees (10 to 60°).

A more detailed description of another embodiment of the hammer of the present invention will now be had with reference to FIG. **4**, which is an enlarged side elevational view of this other embodiment of the hammer of the present invention, and FIG. **5**, which is a front elevational view of the embodiment of the hammer shown in FIG. **4**. The hammer in the embodiment shown in FIGS. **4** and **5**, hereinafter designated the hammer **128**, includes a mounting end **136** having a throughbore **138** for receiving one of the pivot pins **30** therethrough in connection with the pivot mounting of the hammer between a respective adjacent pair of the plates **24**. The axis PPA of the pivot pin **30** when mounted through the throughbore **138** extends parallel to the axis of rotation of the plates **24**.

The hammer **128** also includes an extending portion **140** extending from the mounting end **136** and terminating in a distal end **142** with the center of mass CGM of the hammer being located in the extending portion **140**. The extending portion **140** has a non-linear body portion **144** and a linear body portion **146** with the non-linear body portion **144** being located intermediate the linear body portion **146** and the throughbore **138**. The linear body portion **146** is inclined in a direction opposite to the rotation direction PDR of the plates **24** at a backset angle BST between five to forty-five degrees (5 to 45°) as measured relative to a reference line RFL extending through the center of the pivot pin **30** and the center of mass CGM of the hammer. The backset angle BST is most preferably between fifteen to twenty-five degrees (15 to 25°) as measured relative to the reference line RFL.

With reference to FIG. **5**, it can be seen that the linear body portion **146** and the non-linear body portion **144** of the extending portion **140** of the hammer **128** together comprise the height extent of the extending portion **140**, as measured radially to the pivot pin axis PPA from the distal end **142** to the pivot pin axis PPA. The non-linear body portion **144** of the extending portion **140** of the hammer **128** has a radius of curvature ROC of between ten to sixty degrees (10 to 60°). The hammer **128** has a width extent WID at the distal end **142** as measured parallel to the pivot pin axis PPA. The width extent WID of the hammer **128** is the same along the entire extents of the linear body portion **146** and the non-linear body portion **144**.

Since the invention is susceptible to various modifications and alternative forms, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the scope of the invention extends to all modifications, equivalents and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A hammer for a material size reducing machine, the material size reducing machine including a rotor on which a plurality of hammers are individually pivotally mounted, the hammer comprising:

a mounting end having a throughbore for receiving a pivot pin therethrough in connection with the pivot mounting of the hammer on the rotor, whereupon the axis of the pivot pin when mounted through the throughbore extends parallel to the axis of rotation of the rotor;

an extending portion extending from the mounting end and terminating in a distal end with the center of mass of the hammer being located in the extending portion and having a height extent measured radially from the pivot pin axis to the distal end of the extending portion;

the extending portion having a non-linear body portion and a linear portion;

the non-linear body portion being located intermediate the linear body portion and the throughbore;

the linear body portion being inclined in a direction opposite to the direction of rotation of the rotor as measured relative to a line extending through the center of the pivot pin and the center of mass of the hammer;

the non-linear body portion having a height extent measured from the pivot pin axis to the bottom most edge of the linear body portion of 50% to 90% of the height extent of the extending portion; and

the linear body portion having a planar face and having a height extent measured from the distal end to the top most edge of the non-linear body portion of 10% to 50% of the height extent of the extending portion.

2. A hammer according to claim 1, wherein the non-linear body portion of the extending portion of the hammer has a radius of curvature of between ten to sixty degrees (10 to 60°).

3. A hammer according to claim 1, wherein the linear body portion of the extending portion of the hammer is rectilinear.

4. A hammer according to claim 1, wherein the non-linear body portion has a width extent that from the bottom most edge of the linear body portion to the pivot pin axis tapers symmetrically inwardly from both sides of the non-linear body portion.

5. A hammer according to claim 4, wherein the width extent of the linear body portion and the non-linear body portion are the same along the entire extent of the hammer.

6. A hammer according to claim 4, wherein the width extent of the non-linear body portion is narrowest at a height above the pivot pin axis of between 20% to 70% of the height extent of the extending portion of the hammer.

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